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Expanding the geographical distribution of *Astyanax biotae* Castro & Vari, 2004 (Characiformes, Characidae), with comments on its conservation status

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Abstract

Astyanax biotae Castro & Vari, 2004 was only known from the type locality, a first-order stream from the lower Paranapanema River, a left bank tributary from the upper Paraná river basin. We report *A. biotae* from the Ivinhema River, rio do Peixe and other tributaries of Paranapanema River, expanding its distribution to both margins of the Paraná River. *Astyanax biotae* is zooplanktivorous and regarding its conservation status, can be classified as Least Concern.

Key words

Neotropics; Ivinhema River; rio do Peixe; Paranapanema River; South America.

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Introduction

The upper Paraná river basin, which comprises the region upstream of Itaipu Reservoir (Agostinho and Júlio Jr 1999, Graça and Pavanelli 2007), represents one of the best sampled rivers in Brazil (Castro et al. 2005, Graça and Pavanelli 2007, Langeani et al. 2007).

Among the hundreds of fish species that inhabit the upper Paraná River, there are 7 species of *Astyanax* Baird & Girard, 1854 (Lima et al. 2003, Graça and Pavanelli 2007, Langeani et al. 2007, Vari and Castro 2007, Garutti and Langeani 2009, Lucena and Soares 2016). *Astyanax* is one of the most diverse genera in the Characidae (Schmitter-Soto 2017). The genus is widely distributed in the Neotropics (Casciotta et al. 2005) and does not form a monophyletic clade (Mirande 2010, Rossini et al. 2016). The most encompassing taxonomic revision of *Astyanax* was made by Eigenmann (1910, 1917, 1921, 1927) who proposed the current definition of the genus. Following Eigenmann (1921), the genus is diagnosed by a combination of characters: 2 rows of premaxillary teeth, 5 teeth in the inner premaxillary series, lateral line complete, adipose fin present and caudal fin naked.

Astyanax biotae Castro & Vari, 2004 (Fig. 1) was described from a single locality, a first-order stream situated about 2.5 km from the mouth of the Paranapanema River, left bank of upper Paraná River. Thirteen years after its description, *A. biotae* is still only known from its type locality. The examination of *Astyanax* samples deposited at the DZSJRP (Departamento de Zoologia e

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Figure 1. *Astyanax biotae*. **A.** MZUSP 79807, paratype, 42.5 mm SL, Paraná state, municipality of Diamante do Norte, córrego Água Mole, affluent of Paranapanema River, 22°38′31″ S, 052°48′59″ W. **B.** MZUEL 4529, topotype, 55.0 mm SL. **C.** NUP 15137, 44.1 mm SL, Mato Grosso do Sul state, municipality of Jateí, Peroba creek, affluent of Ivinhema River, 22°54′54″ S, 053°39′07″ W.

Table 1. Morphological data of *Astyanax biotae*. OD = original description, data from Castro and Vari (2004). Paratypes = 14; Topotypes = 7; New localities = 28 specimens analyzed.

Characters	OD	Paratypes	Topotypes	New localities
	Min–Max	Min–Max	Min–Max	Min–Max
Standard length (mm)	31.2–52.5	35.5–44.8	40.2–55.0	30.5–44.1
Morphometric				
Percentages of Standard Length				
Predorsal distance	50.4–56.9	50.7–52.7	50.1–54.2	50.5–56.5
Prepelvic distance	45.7–49.8	46.1–49.3	45.1–47.9	45.2–49.2
Prepectoral distance		27.7–28.8	26.8–28.5	26.8–30.6
Preanal distance	61.4–66.8	61.4–65.5	61.9–64.8	60.9–65.3
Body depth	34.7–41.8	35.2–41.1	35.4–41.3	35.1–41.9
Caudal peduncle depth	10.9–13.7	11.5–13.1	12.4–13.8	10.7–12.5
Caudal peduncle length	9.4–12.8	11.4–13.8	11.6–13.8	9.8–13.6
Dorsal-fin length	26.8–30.8	28.2–29.9	26.0–30.8	26.5–31.8
Pelvic-fin length	16.0–19.2	17.3–19.7	16.2–18.6	16.8–19.1
Pectoral-fin length	19.2–24.4	21.8–24.9	21.4–23.1	19.6–24.9
Anal-fin length		18.4–23.7	17.2–21.4	20.3–23.7
Length of anal–fin base	29.1–39.6	31.7–36.9	33.2–35.3	30.7–36.3
Head length	25.4–28.7	26.1–28.2	25.9–27.1	26.8–28.9
Distance from eye to dorsal fin		38.9–42.5	39.0–43.0	37.8–43.9
Distance from pectoral–fin origin to pelvic–fin origin		17.1–21.4	17.3–22.3	18.2–22.6
Distance from pelvic– to anal–fin origins		16.3–19.4	15.2–18.6	15.1–18.8
Percentages of Head Length				
Snout length	23.5–29.3	23.9–25.3	22.2–27.2	22.3–26.8
Upper jaw length		39.8–46.4	39.2–46.6	39.7–44.8
Orbital diameter	31.9–40.0	38.1–41.6	33.5–36.9	35.5–41.4
Interorbital distance	34.8–40.9	35.0–40.1	35.8–41.7	35.5–40.5
Meristic				
Humeral spots	2	2	2	2
Teeth of external series/maxilla	4/1	4–5/1–2	3–4/1	3–5/1–2
Dentary massive teeth	4	4–5	4–5	4–5
Symphyseal tooth cusps	4	4–5	4–5	4–5
2nd and 3rd teeth cusps of internal series	5	4–5	4–5	4–5
Maxilla cusps	3–5	3–5	3–5	3–5
Lateral line scales	32–35	32–35	33–35	32–35
Series of scales above/under lateral line	6–7/4–5	6–7/4–5	6–7/5	6–7/5
Predorsal scales	10–14	10–12	10–11	10–13
Circumpeduncular scales	13–15	13–14	12–14	13–15
Scales covering base of anal fin		10–14	9–15	9–18
Dorsal-fin rays	ii, 9	ii, 9	ii, 9	ii. 9
Pectoral-fin rays	i, 10–12	i, 10–12	i, 11–12	i. 11–13
Pelvic-fin rays	i, 6–7	i, 6–7	i, 7	i. 6–7
Anal-fin rays	ii–iv, 22–26	iii–iv, 22–26	iii–iv, 22–26	iii–v. 21–26
Gill-rakers on upper/lower branch	6/11	6–8/10–11	6–7/10–12	6–8/10–12
Color				
Humeral spots	Vertical	Vertical	Vertical	Vertical
Lateral body stripe	Inconspicuous	Inconspicuous	Inconspicuous	Inconspicuous

Botânica da Universidade Júlio de Mesquita Filho, São José do Rio Preto, Brazil) and NUP (Coleção Ictiológica do Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura, Maringá, Brazil) fish collections previously identified as *Astyanax* sp. resulted in the first record of *A. biotae* in additional tributaries of right and left banks of the rio Paraná.

Methods

Counts and measurements were taken following Fink and Weitzman (1974) and Menezes and Weitzman (1990), except for number of scales series below the lateral line, which follows Bertaco and Lucena (2006). Additional measurements include: (1) the distance from pectoral- to pelvic-fin origins; (2) the distance from pelvic- to anal-fin origins. Measurements were taken point-to-point using a digital caliper to the nearest 0.1 mm, on the left side of the fish. All measurements are expressed as percentages of SL, except those subunits of the head, which are expressed as percentages of head length (HL). In Table 1, proportions were rounded to 0.1%.

The comparative diagnosis for the following species

was based on the morphological data taken from literature: *Astyanax aramburui* Protogino, Miquelarena & Lopes, 2006, *A. latens* Mirande, Aguilera & Azpelicueta, 2004, *A. tupi* Azpelicueta, Mirande, Almirón & Casciotta, 2003 and *A. saguazu* Casciotta, Almirón & Azpelicueta, 2003 (from their original descriptions); *A. correntinus* (Holmberg, 1891) and *A. pelegrini* Eigenmann, 1907 (from Mirande et al. 2006); *A. erythropterus* (Holmberg, 1891) (from Soneira et al. 2010); *A. stenohalinus* Messner, 1962 (from Almirón et al. 2010).

Abbreviations of ichthyological collections are: DZSJRP (Departamento de Zoologia e Botânica, São Paulo State University, São José do Rio Preto, São Paulo, Brazil); MZUEL (Museu de Zoologia, Universidade Estadual de Londrina, Londrina, Brazil); MZUSP (Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil); NUP, and USNM (National Museum of Natural History, Smithsonian Institution, Washington, DC, USA).

Stomachs of 10 *A. biotae* were analyzed by the volumetric method (Hyslop 1980). The identification of the organisms was done under a stereoscopic microscope, and with the help of literature for the lowest possible taxonomic level.

Results

Materials examined. Brazil, upper Paraná River drainage.

Type specimens: MZUSP 79807, 4 of 10, 35.5–44.8 mm SL, Paraná state, municipality of Diamante do Norte, córrego Água Mole, tributary of Paranapanema River, 22°38′31″ S, 052°48′59″ W, 7 Aug. 2000, R.M.C. Castro et al. USNM 373492, 10 of 15, 43.8–52.0 mm SL, same data.

Topotypes: MZUEL 4529, 7 of 23, 40.2–55.0 mm SL, 11 Dec 2008, F.C. Jerep, E.S. Silva & A. Souza.

New localities: DZSJRP 7510, 5 of 18, 30.5–38.1 mm SL, Mato-Grosso do Sul state, municipality of Angélica, córrego da Égua, tributary of Ivinhema River, 22°10′30″ S, 053°50′10″ W, 22 Apr. 2005, H.F. Chaves & L.G.G. Silveira. DZSJRP 13285, 6 of 7, 21.0–39.5 mm SL, São Paulo state, municipality of Planalto do Sul, stream tributary of Córrego da Lagoa next the urban perimeter, tributary of Paraná River, 22°18′05″ S, 52°14′05″ W, 30 Oct. 2011, A.R. Manzotti & G.H. Baviera. DZSJRP 14336, 5 of 5, 33.6–38.0 mm SL, São Paulo state, municipality of Planalto do Sul, stream tributary of Córrego da Lagoa next the urban perimeter, tributary of Paraná River, 22°18′06″ S, 52°14′16″ W, 30 Oct. 2011, A.R. Manzotti & G.H. Baviera. DZSJRP 14384, 1 of 1, 27.7 mm SL, São Paulo state, municipality of Estrela do Norte, stream Água da Divisa at Alvorada farm, tributary of Rebojo stream, rio Paranapanema sub-basin, 22°33′33″ S, 51°43′09″ W, 25 Sept. 2011, A.R. Manzotti & G.H. Baviera. DZSJRP 16455, 1 of 1, 34.3 mm SL, São Paulo state, municipality of Dracena, Prado stream, rio do Peixe sub-basin, 21°38′59″ S, 51°32′36″ W, M. Tassoni Filho, 14 Dec. 2011. NUP 15137, 10 of 18, 35.6–44.1 mm SL, Mato Grosso do Sul state, municipality of Jateí, Peroba creek at Parque Estadual das Várzeas do Rio Ivinhema (PEVRI), affluent of rio Ivinhema, 22°54′54″ S, 53°39′07″ W, 15 Nov. 2012, A.G. Oliveira.

Identification. *Astyanax biotae* (Table 1) differs from all congeners inhabiting La Plata River basin, except *A. latens* (Bermejo River); *A. aramburui*, *A. correntinus*, *A. erythropterus*, *A. pelegrini* and *A. tupi* (lower Paraná–Paraguay River); *A. stenohalinus* and *A. saguazu* (Uruguay River) by having the terminus of the dorsal-fin base situated along the vertical through branched anal-fin rays (vs through unbranched anal-fin rays or anterior to anal-fin origin). *Astyanax biotae*, by having 32–35 lateral line scales, differs from *A. aramburui* (vs 38–42), *A. correntinus* (vs 39–42), *A. erythropterus* (vs 49–54), *A. latens* (vs 37–38), *A. pelegrini* (vs 46–52), *A. saguazu* (vs 37–39) and *A. stenohalinus* (vs 37–39). From *A. tupi*, it differs by having 17–21 gill-rakers (vs 24–25). *Astyanax biotae* is not assigned to any *Astyanax* species complex currently recognized for the genus. The following characters distinguish *A. biotae* from *Astyanax* species complexes: presence of a vertically elongate black humeral blotch (vs humeral blotch horizontally elongate, oval-shaped in *A. bimaculatus* species complex, see Garutti and Langeani 2009); presence of 22–26 anal-fin rays (vs 25 or more in *A. fasciatus* species complex, see Melo and Buckup 2006 and vs 13 to 23 in *A. scabripinnis* species complex, see Bertaco and Lucena 2006).

Discussion

The discovery of *A. biotae* in 2004 was a result of the extensive fauna study implemented by the Program BIOTA/FAPESP through the thematic project "Fish diversity of the headwaters and streams of the upper Paraná river system in the state of São Paulo, Brazil". Castro and Vari (2004) described *A. biotae* solely based on material from the lower Paranapanema River, its type locality. The type locality of *A. biotae* is a first order creek surrounded by a narrow area of native vegetation. For that reason, Castro and Vari (2004) suggested that the species may be at risk of extinction since the area was threatened by several anthropogenic activities (e.g. deforestation, extensive use of fertilizers and pesticides in agricultural practices). Here we report that *A. biotae* also occurs in São Paulo state (rio do Peixe basin, and tributaries of lower Paranapanema River and Paraná River, all left bank of upper Paraná River) and Mato Grosso do Sul state (Ivinhema River basin, right bank of upper Paraná River) (Fig. 2).

Even though the known geographic distribution of *A. biotae* is still restricted to a relatively small area in the upper Paraná drainage and most sites are threatened by anthropogenic activities, no threats were detected in rio Ivinhema at Parque Estadual das Várzeas do Rio Ivinhema (PEVRI) (Fig. 3). Therefore, *A. biotae* can be classified as Least Concern, according to the International Union for Conservation of Nature criteria (IUCN 2017).

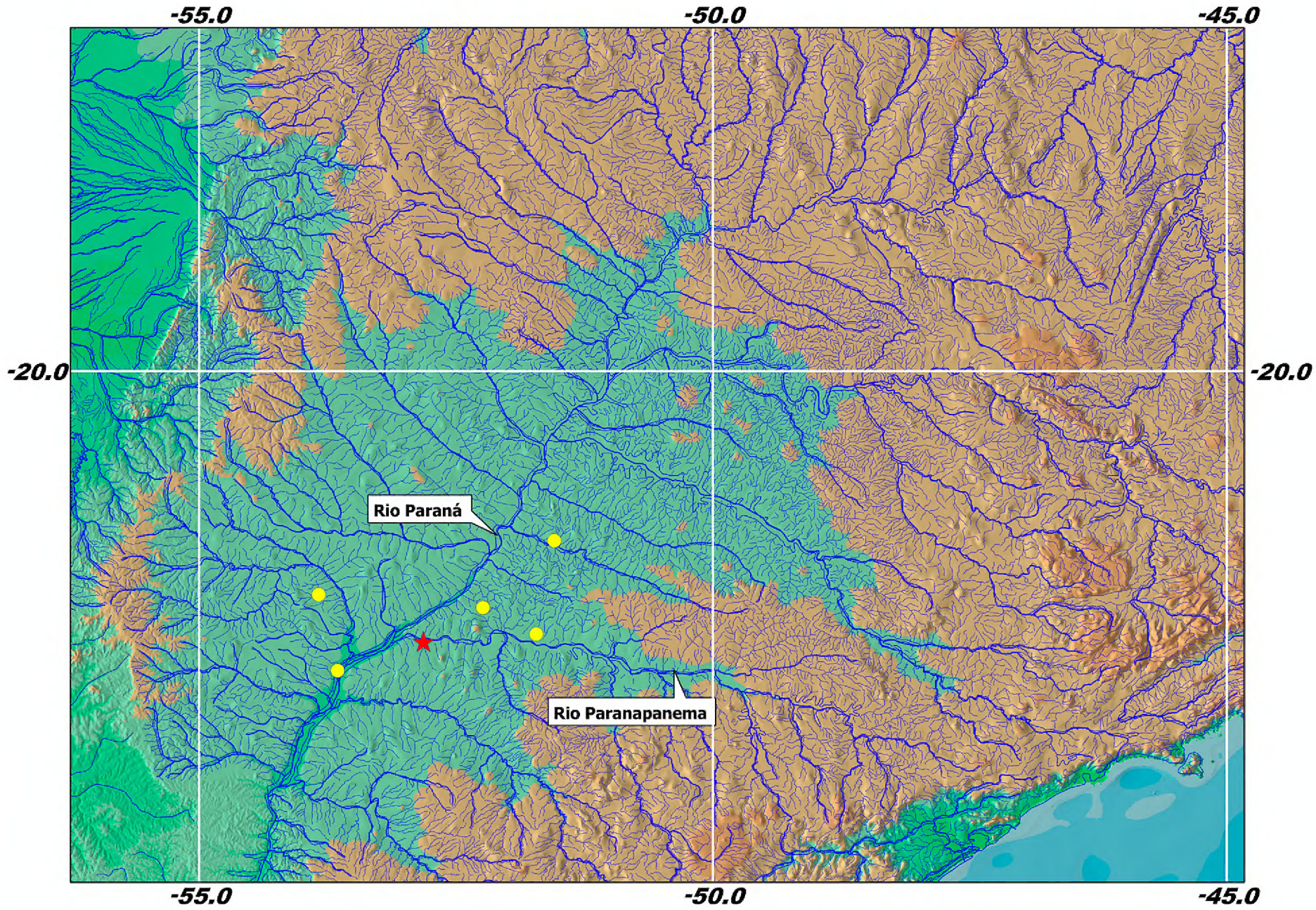

Figure 2. Map of Central Brazil showing the records of *Astyanax biotae*. Red star indicates the type locality and yellow dots new records for the species.

Figure 3. Brazil, Mato Grosso do Sul state, municipality of Jateí, Peroba creek at Parque Estadual das Várzeas do Rio Ivinhema (PEVRI), affluent of Ivinhema River, 22°54'54" S, 053°39'07" W, locality of collection of *Astyanax biotae*.

The feeding habits for the specimens from rio Ivinhema were also determined. *Astyanax biotae* can be considered zooplanktivorous, as more than 80% of its diet was composed by microcrustaceans, mainly Copepoda. The other items consumed were chironomid larvae, ephemeropteran naiads, and fruits.

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Authors' Contributions

CAMO and CSP made the taxonomic study, AGO made the diet and reproductive analyzes and CAMO wrote the text.

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